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Gait stability indices and their relationship with clinical scale scores in stroke patients

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INTRODUCTION

Stroke patients are at particular risk for falling [1]. Gait stability, defined as the capacity of maintaining equilibrium minimizing accelerations at upper body level [2], is considered as a major factor in fall risk assessment [3]. To quantify gait stability, clinical scales are normally used in clinics. However, they are highly operator-dependent thus lacking reliability [3]. On the other hand, objective methods exist that quantify gait stability in terms of acceleration at upper body level and its attenuation going from the lower to the upper trunk and head. These methods, often based on the use of wearable sensors, have been validated both in healthy [4] and pathological subjects [5]. However, with regard to stroke patients, no information is available. Moreover, the relationship between the acceleration attenuation and clinical scale scores is not clear. The purpose of the present study is to fill this gap.

METHODS

Fourteen sub-acute stroke patients (PG) (age 40-90 years, Functional Ambulation Scale ≥ 3) and 14 healthy adults (CG) were included in the study. The Barthel Index, Tinetti Balance and Gait Scale, Berg Balance Scale (BBS), and Functional Ambulation Scale (FAC) were administered to each patient. Participants performed a 10m-walking test wearing 3 inertial sensors located at the pelvis (P), sternum (S), and head (H) levels. The root mean square (RMS) values of each acceleration component (AP, ML, CC) at each body level was calculated and normalized with respect to the participants' walking speed [6]. The attenuation coefficients between each level pair (C_{ij}) were then obtained as described in [4]. To investigate if significant differences existed between PG and CG for both RMS and C_{ij} , a Mann Whitney-U test was performed. In addition, the relationship between C_{ij} and the clinical scale scores was assessed with the Spearman's correlation coefficient (ρ) ($\alpha = 0.05$).

RESULTS

Stroke patients displayed slightly smaller normalized RMS values with respect to CG, for all three levels and components. However, no significant difference was found between the two groups. The values of the attenuation coefficients between each level pair, for both PG and CG, are reported in Fig.1. Moderate to strong significant correlations between C_{ij} and the clinical scale scores were found for the Barthel, Tinetti, and FAC scales ($\rho = 0.51 \div 0.73$), especially with respect to the AP and ML C_{ij} .

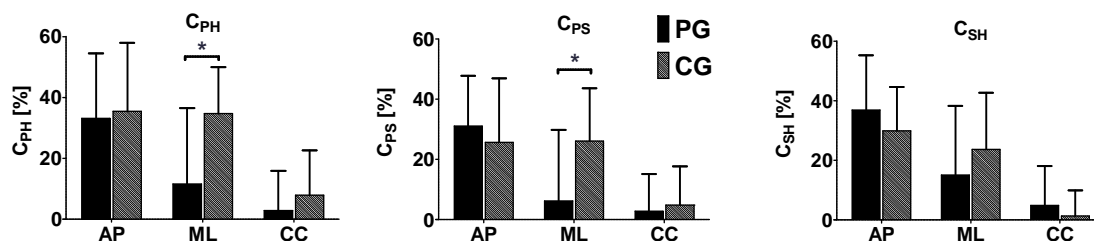


Figure 1: C_{ij} results for each acceleration component. * Significant differences between PG and CG.

DISCUSSION

Although no significant difference was found in the normalized RMS values between the two groups, the PG displayed a reduced attenuation capacity of the accelerations in the medio-lateral direction with respect to CG. This is probably due to the presence of both trunk rigidity and gait asymmetries, as a consequence of hemiparesis, which typically affects these patients. The BBS does not seem an adequate tool for assessing gait stability in stroke patients, whereas a relationship exists between the other clinical scales (Barthel, Tinetti, and FAC) and the attenuation coefficients. *Ad hoc* studies, however, are needed to assess the sensitivity and specificity of these coefficients in clinical contexts.

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